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CHANNEL ISLANDS NATIONAL PARK

TECHNICAL REPORT 98-08

TERRESTRIAL VEGETATION MONITORING CHANNEL ISLANDS NATIONAL PARK 1984–1995 REPORT

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ABSTRACT

Channel Islands National Park began implementation of a long-term plant community monitoring program on Anacapa, Santa Barbara, and San Miguel Islands in 1984. Monitoring on Santa Rosa Island began in 1990. Species present at each of 100 points along 137, thirty-m permanent transects are recorded annually. The number of transects on each island is determined by the island's size and the diversity of its vegetation. Anacapa Island has 16 transects, Santa Barbara Island has 24, and San Miguel Island has 16. Santa Rosa Island has 86. This report presents the data, summarized by transect, that was collected on Anacapa Island, Santa Barbara Island, and San Miguel Island in 1984, 1985, 1986, 1987, 1988, 1990, 1993, 1994, and 1995, and on Santa Rosa Island in 1990, 1993, 1994, and 1995. For analysis of vegetation trends, the transect data should be aggregated by community types. Relative frequency of natives vs. exotics, perennials vs. annuals, and comparison of graminoids, herbs, sub-shrubs, shrubs, and trees can be derived from the data. Substrate information is available beginning in 1993. No analysis is presented in this annual report.

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INTRODUCTION

Channel Islands National Park was created in 1980, subsuming the former Channel Islands National Monument. The Park's enabling legislation (PL 96-199) required that the Park develop a natural resources study including 1) an inventory of all species in the Park including population dynamics, 2) an assessment of present conditions and probable future trends of populations, and 3) recommendations as to what actions should be considered for adoption to better protect the natural resources of the Park.

The Park used this legislation as an opportunity to develop a model system for monitoring natural resources in national parks (Davis and Halvorson, 1988). It also recognized that restoration and protection of Park resources required an ecological monitoring program to assess the effectiveness of these efforts and to determine limits of natural variation, diagnose abnormal conditions, and prescribe potential remedial treatments.

All of the islands have been altered by past land use. The vegetation is in various stages of recovery from grazing, farming, military use, and introduction of exotic species. Monitoring offers an opportunity to measure natural recovery, the effectiveness of management actions to restore island vegetation, and the impacts of unrelated management actions.

The terrestrial vegetation monitoring program was designed to monitor the changes that are taking place in the usual vegetation units or representative plant communities (Halvorson et al. 1988). It is not designed to monitor communities that are unusual because of rarity or location. It is also not intended to be used to monitor individual plant species.

Annual reports provide ongoing documentation of the program's objectives, methods, and results. This report presents the data collected in 1984 through 1995 as well as sampling dates and personnel, any deviations in methods and locations, questions or difficulties that should be resolved prior to more sampling, and suggested modifications to the sampling protocol. Data is analyzed periodically to determine vegetation and trend; the results of analysis are presented in trend reports.

Upcoming projects in the Channel Islands Vegetation Monitoring Program are a trend report based on the 1984 through 1995 data, vegetation map updating, and a program review to evaluate protocols and objectives. Expanded riparian and woody species data collection is planned to be incorporated into the vegetation monitoring program in 1998. Beginning with 1996 data, annual reports are planned to present each year's data individually. Research on the plant communities of eastern Santa Cruz Island was conducted in 1996. Plant community definitions are currently being developed, and permanent transects are expected to be installed on that island in 1998.

VEGETATION MONITORING METHODS

Study Area

Channel Islands National Park consists of 5 of the 8 California Channel Islands (Figure 1). The 4 northern islands—Anacapa, Santa Cruz, Santa Rosa, and San Miguel—are all within the Park boundaries; Santa Barbara Island is the only southern island within the Park. These islands lie 20–73 km off the coast of Southern California and range in size from 260 ha (Santa Barbara Island) to 25,000 ha (Santa Cruz Island). The total area of the Park is 100,000 ha, divided nearly equally between submerged lands and the islands. Anacapa Island is the closest to the mainland and lies 22 km from the mainland headquarters in Ventura, while the western outpost, San Miguel Island, is 100 km from Ventura.

The terrestrial vegetation of the Channel Islands is strongly influenced by a Mediterranean climatic regime. This

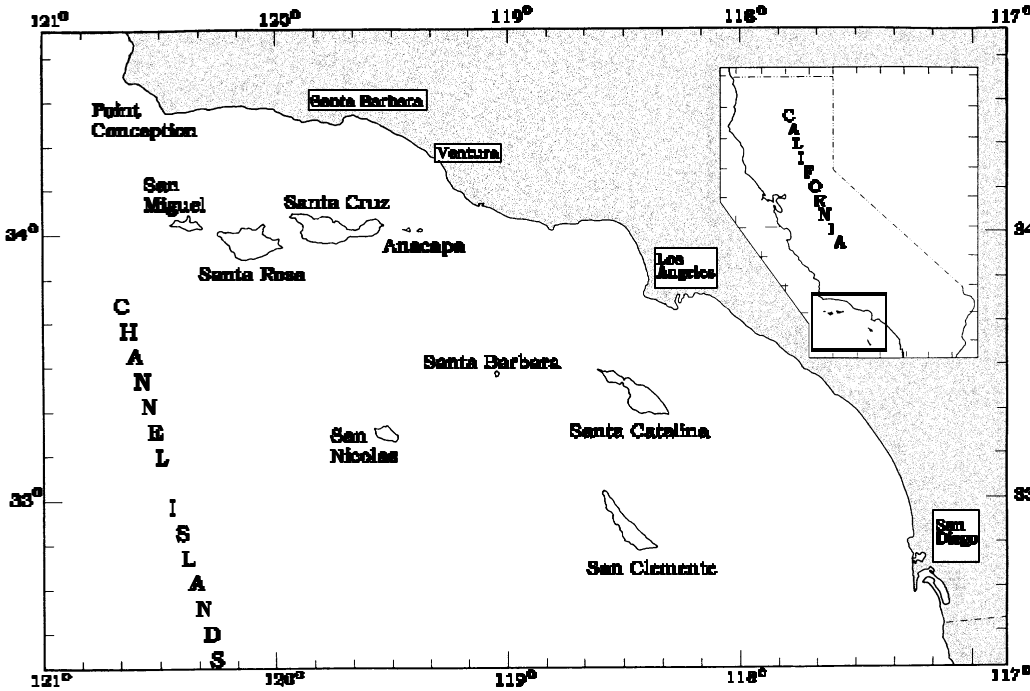

Figure 1 Channel Islands National Park, California. The Park includes San Miguel, Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara Islands

climate has a strong maritime influence with moderate year-round temperatures, coastal fog, precipitation during winter months, and virtually no rain from May to October.

History

Channel Islands National Park began formal implementation of its Terrestrial Vegetation Monitoring Program in 1984 with installment of permanent transects on Anacapa, Santa Barbara, and San Miguel Islands. In addition to the new transects, the Park utilized transects that had been established on Anacapa and Santa Barbara Islands by the Santa Barbara Botanic Garden in 1978. These transects were established to provide vegetation information for the *Natural Resources Study of the Channel Islands National Monument, California* (Power et al. 1979; Junak et al. 1983).

The Natural Resources Study was conducted in anticipation of a change in Channel Island's status from Monument to Park. The purpose of the study was "to obtain baseline information that can be used in the development of a General Management Plan, in the analysis of possible impacts of management strategies, and as a background for future research" (Power et al. 1979, p 1.1). The transects themselves aimed "to document the present distribution of individual species in each plant community and to establish a system to monitor future change" (Power et al. 1979, p 5.70). S. Veirs, who designed the Park's first vegetation monitoring program, incorporated the Santa Barbara Botanic Garden transects in order to take advantage of the data already collected. The Santa Barbara Botanic Garden transects used a line-intercept protocol that is compatible with the point-intercept technique chosen by the Park. The data collected before 1984 have not yet been converted to point format and are not presented in this report.

Table 1 Communities monitored on each island and the transects that represent them

Community	Transects
Santa Barbara Island	
Boxthorn Scrub	08N, 16
Cactus Scrub	09N, 10N, 14
Coastal Sage Scrub	20
Coreopsis Scrub	09S, 10S, 11, 12, 15, 17, 21
Grassland	01, 06, 18, 19
Seablite Scrub	02, 03, 04, 05
Sea Cliff Scrub	07, 08S, 13
Anacapa Island	
Coreopsis Scrub	01W, 02W, 03E
Coastal Sage Scrub	02M, 03W, 04W
Grassland	01M, 02E, 03M, 04E, 04M, 05M, 05W, 06W
Perennial Iceplant	01E, 05E
San Miguel Island	
Caliche Scrub	01, 02
Island Chaparral	06, 07, 08, 12
Coreopsis Scrub	13, 15, 16
Coastal Sage Scrub	05, 11, 18
Coastal Dune Scrub	14
Grassland	03, 04, 10
Sea Cliff Scrub	09
Santa Rosa Island	
Baccharis Scrub	02, 05, 14, 15, 26, 27, 28, 29, 30
Caliche Scrub	45, 46
Coastal Bluff Scrub	49, 50, 51
Island Chaparral	11, 13, 20, 21, 34, 35
Coastal Sage Scrub	40, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61
Grassland	01, 04, 08 ,09, 10, 12, 19, 22, 23, 24, 25, 31, 32, 33, 36, 37, 38, 39, 42, 43, 44, 47,48
Lupine Scrub	16, 17, 18
Coastal Marsh	06, 07
Mixed Woodland	63, 68, 69, 70, 71, 76, 79
Oak Woodland	74, 75, 77, 78
Riparian (herbaceous and woodland)	80, 81, 82, 83, 84, 85, 86
Santa Cruz Island Pine	72, 73
Coastal Strand	03, 41
Torrey Pine	62, 64, 65, 66, 67

Vegetation classification field work, a prerequisite for vegetation mapping and placement of monitoring sites, was carried out on San Miguel Island by J. Lenihan, W. Lennox, and S. Veirs in 1983 (Lenihan et al. 1983). Classification studies were done on Santa Rosa Island by W. Halvorson and K. Danielsen in 1988 (Clark et al. 1990). Vegetation mapping and installation of 85 transects was completed on Santa Rosa Island in 1989, and data were first collected in 1990.

While the number of transects read annually vary due to weather, missing markers, and nesting seabirds, most transects are read in most years. The exceptions to this have been 1989, 1991, and 1992 when no data collection was done due to lack of staff. This problem has now been resolved by hiring a permanent monitoring botanist for the Resources Management staff.

The communities monitored and the transects that represent them on each island are listed in Table 1. Transect locations are shown in Figure 2 (Santa Barbara Island), Figure 3 (Anacapa Island), Figure 4 (San Miguel Island), and Figure 5 (Santa Rosa Island). It is expected that upcoming analysis of the transect data may modify community definitions or indicate addition or deletion of transects in some communities.

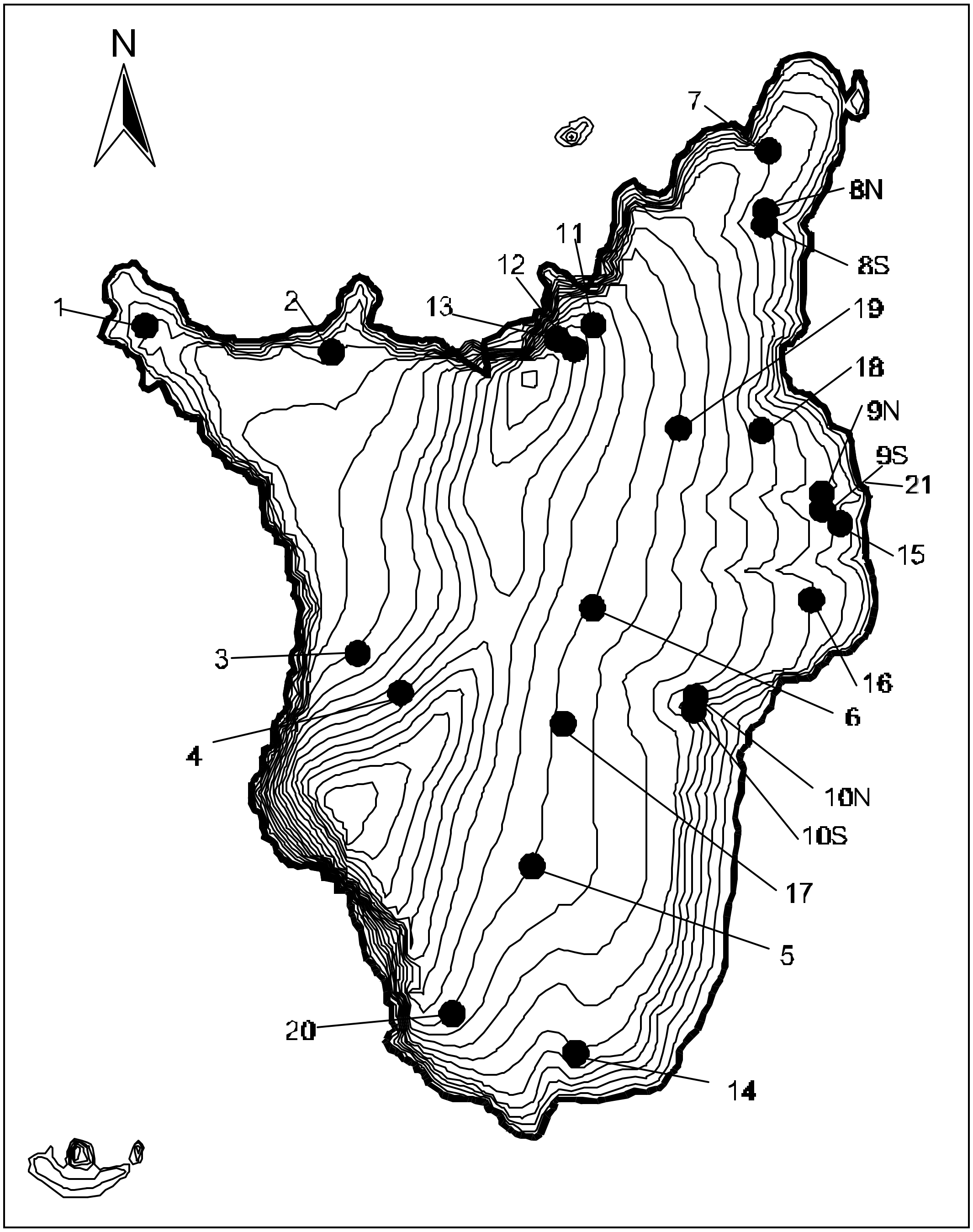

Figure 2 Transect locations on Santa Barbara Island

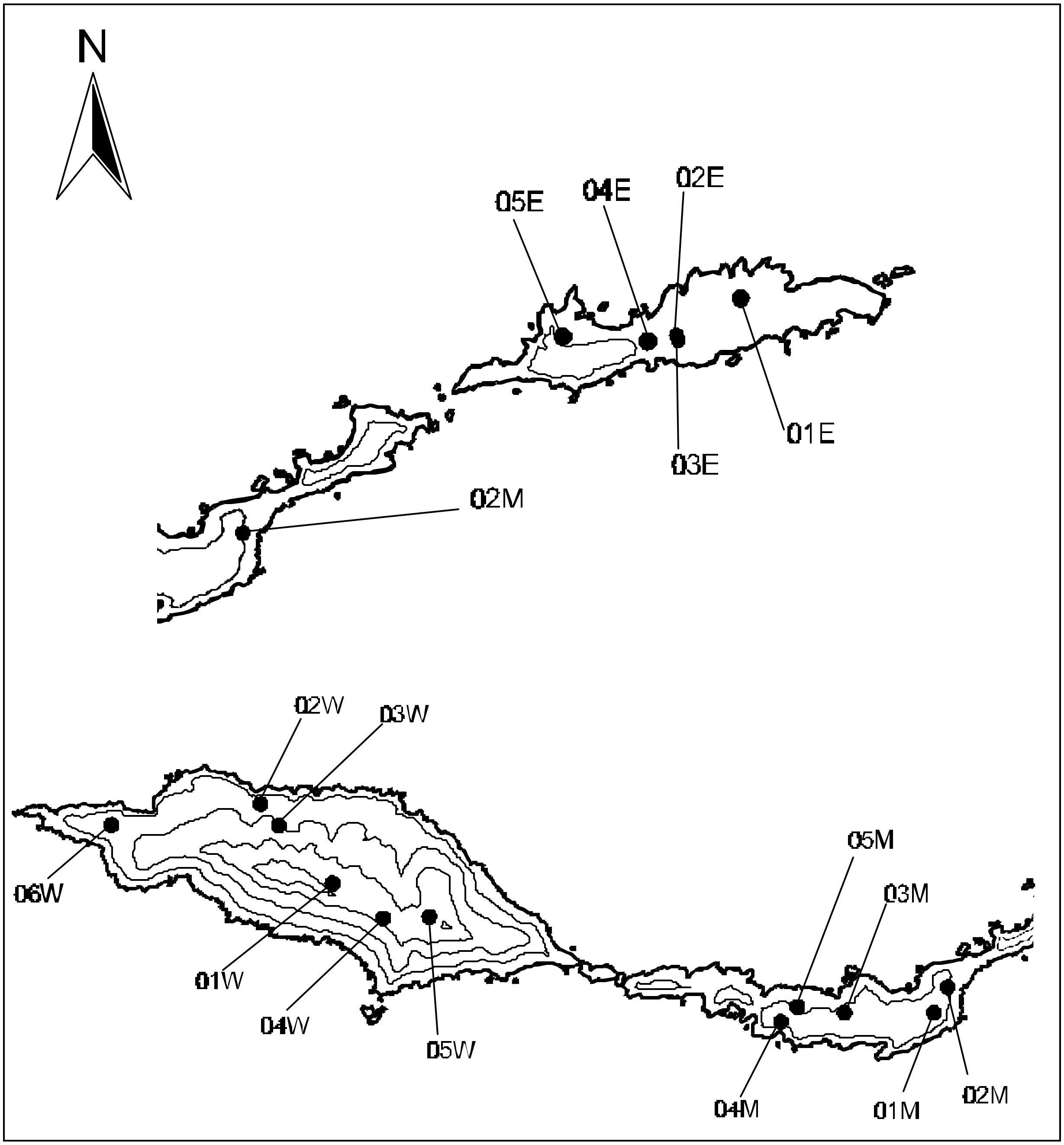

Figure 3 Transect locations on East Anacapa Island (top) and West and Middle Anacapa Island (bottom)

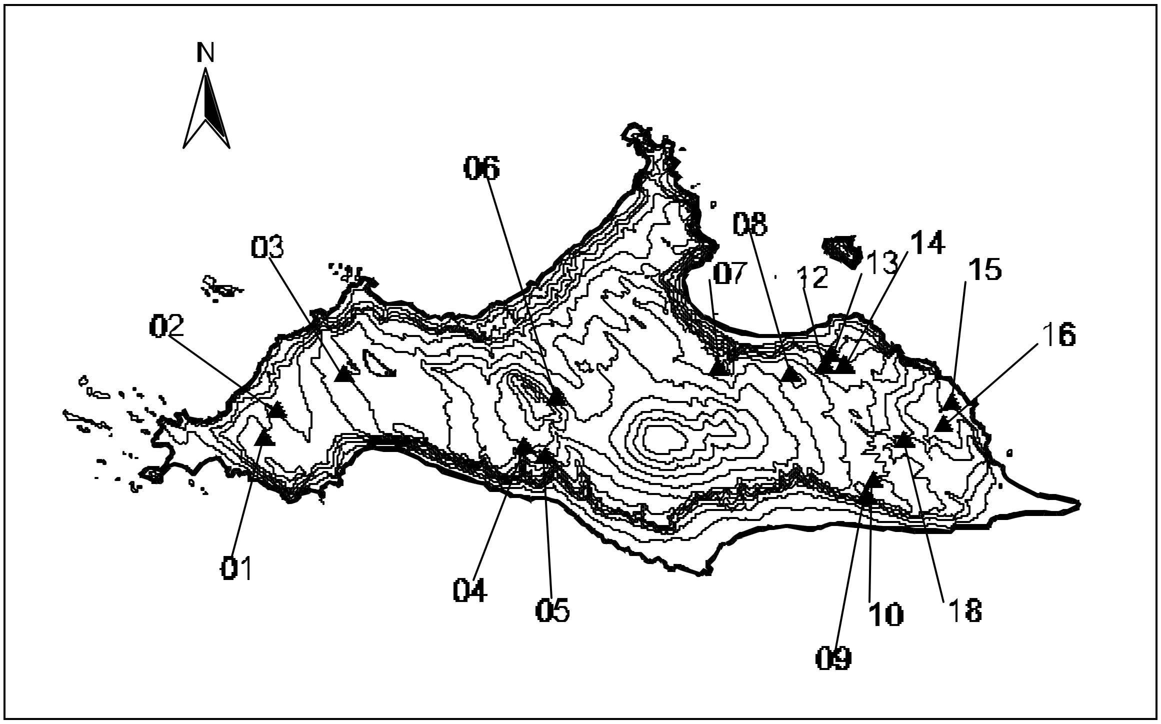

Figure 4 Transect locations on San Miguel Island

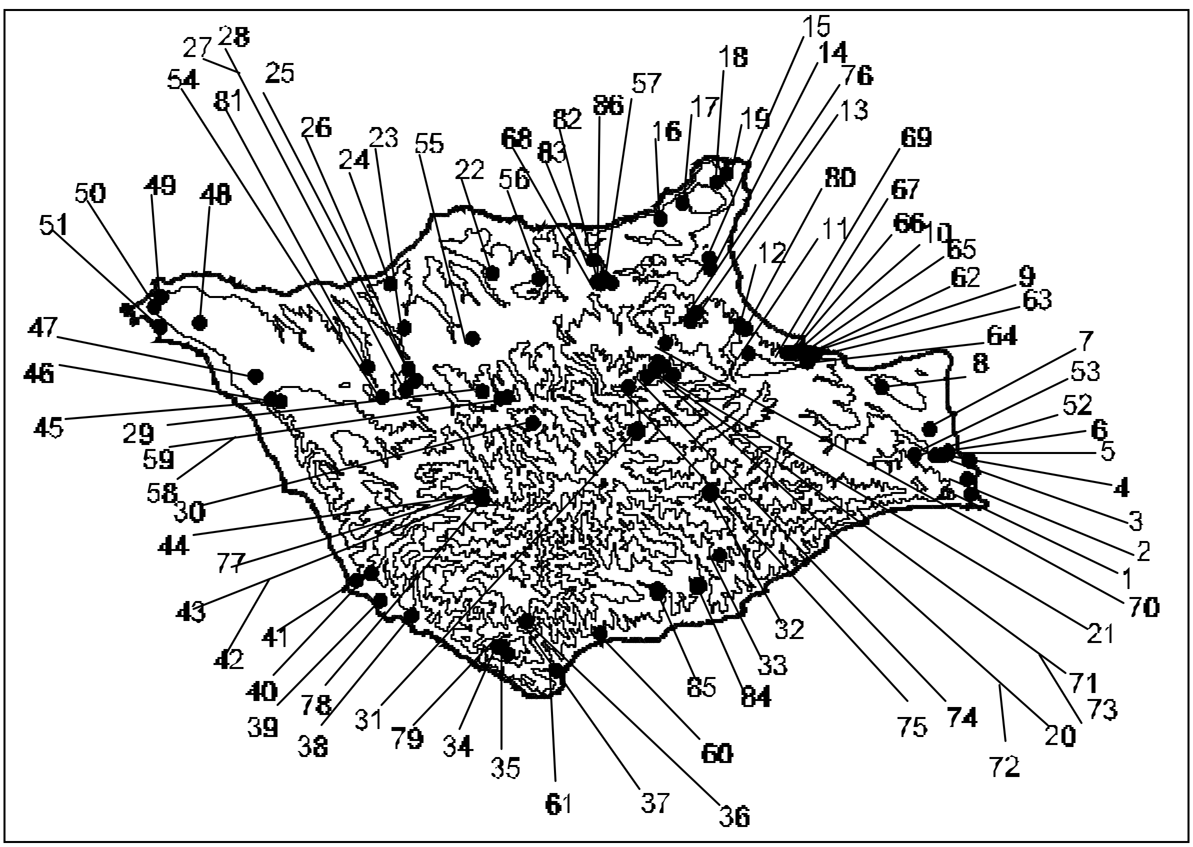

Figure 5 Transect locations on Santa Rosa Island

Community Descriptions

Each Park island supports a unique assemblage of vegetation communities. The differences are often subtle, and are due to different weather and climates, geology, soils, and land use history. Long-term monitoring is intended, in part, to reveal whether differences we see now are natural/inherent or are the result of past land use practices which may have served to simplify the vegetation of all the islands. Grasslands composed of exotic annual grass species now occupy areas formerly comprising a mosaic of perennial grasslands and shrublands.

A brief description of the island communities is included here. For more detailed information, see Philbrick and Haller 1977, Powers 1979, Junak et al. 1980, Lenihan 1983, Halvorson et al. 1988, and Clark et al. 1990. Table 1 lists the monitored communities.

Santa Barbara Island

This small island is dominated by exotic **grassland.** This plant community, which occupies more than half of the island, is composed of annual *Avena*, *Bromus*, and *Hordeum* species. The low-growing exotic sub-shrub, Australian saltbush (*Atriplex semibaccata)*, is an important component of the grassland in some areas. A few individuals of coyote brush (*Baccharis pilularis)* occur in the grasslands and may be the leading edge of a new wave of coyote brush colonization. A handful of shrub communities occurs on Santa Barbara Island. These are boxthorn scrub, cactus scrub, Coreopsis scrub, sea cliff scrub, annual iceplant, coastal sage scrub, and seablite scrub. There are no trees on Santa Barbara Island.

The **boxthorn scrub** community is dominated by low-growing, thorny *Lycium californicum*. Boxthorn provides habitat for the federally Endangered island night lizard (*Xantusia riversiana*). The community is most common on the eastern terrace of the island and is closely associated with cactus scrub and grassland communities. **Cactus scrub** occurs primarily on south-facing slopes and is characterized by prickly pear (*Opuntia littoralis*) and cholla (*O. prolifera*). **Coreopsis scrub** presents the impression of a pygmy forest. The dominant semi-succulent, arborescent shrubs (*Coreopsis gigantea*) may form seasonally-closed canopies over a sparse understory in older stands, or they may be interspersed with dense grass cover in younger stands. **Sea cliff scrub** occurs on the steep slopes that rim Santa Barbara Island. The inaccessibility of the cliffs has protected silverlace (*Eriophyllum nevinii*), buckwheat (*Eriogonum giganteum* s. *compactum*), and coastal sagebrush (*Artemisia californica, A. nesiotica*) from depredation by introduced rabbits or eradication by human management activities. This diverse shrub community provides habitat for nesting California Brown Pelicans (*Pelecanus occidentalis californicus*) and Xantus' Murrelets (*Synthliboramphus hypoleuca*). **Coastal sage scrub** occurs primarily on the southern and eastern areas of the island. California sagebrush (*Artemisia californica, A. nesiotica*) has been slowly expanding its range on the island since the elimination of rabbits (Drost, NPS files). **Seablite scrub** tends to be a rather open community with large patches of bare ground. Seablite (*Suaeda taxifolia*) occurs most frequently with annual grasses and crystalline iceplant (*Mesembryanthemum crystallinum*). Annual **iceplant** (*Mesembryanthemum crystallinum, M. nodiflorum*) currently dominates some areas that originally were native grassland or shrubland. The native communities were eliminated or degraded by agricultural practices. Iceplant readily colonized the bare ground but did not protect from soil erosion. Loss of topsoil has created an environment that discourages the natural re-establishment of native species.

Anacapa Island

East and Middle Anacapa are flat plateaus while West Anacapa is a mountainous ridge. This, in addition to different land use histories, has led to some differences in vegetation. All three islets have **sea cliff scrub** on their northern slopes and **coastal sage scrub** on their southern slopes. These communities are well developed on West Anacapa Island, moderately developed on Middle Anacapa Island, and marginal on East Anacapa Island. Large areas on East Anacapa Island are covered by perennial **iceplant** (*Carporotus chilensis, C. edulis, Malphora crocea*) introduced by the U.S. Coast Guard for erosion control. These alien species are much less common on the other two islets. Mixed annual and perennial **grassland** are well distributed on East Anacapa Island and Middle Anacapa Island but patchier on West Anacapa Island. **Coreopsis scrub** occurs in small, scattered stands on East Anacapa Island and in more extensive stands on Middle Anacapa Island and West Anacapa Island.

San Miguel Island

A striking feature of San Miguel Island vegetation is the pronounced northwest-southeast orientation of the communities. This is the result of the influence of the strong, nearly constant northwesterly winds on the island's sandy soils. The many parallel ridges are stabilized sand dunes, which are interspersed in some areas with unstabilized blowouts or erosion pavement. **Beach and coastal dunes** support little vegetation beyond exotic sea rocket (*Cakile maritima*) and native sand verbena (*Abronia maritima*). Increasing distance from salt spray allows more diverse vegetation, including beachbur (*Ambrosia chamissonis*) and beach primrose (*Camissonia cheiranthifolia* s. *cheiranthifolia*) to develop on coastal dunes. Inland dunes that are becoming moderately stabilized frequently support lush **lupine scrub**. **Grassland** and **Iscoma scrub** (formerly known as Haplopappus scrub) are the dominant plant communities occurring on all parts of the island. **Caliche scrub,** a primarily herbaceous community, is extensive on the west end of the island and spotty elsewhere. **Coastal sage scrub** is most extensive on the island's steep southern escarpment frequently intermixed with **sea cliff scrub**. It also occurs on some south facing canyon walls occasionally forming impenetrable thickets. **Island chaparral** is extremely depauperate on San Miguel Island. The most consistent shrub member of the community is coyotebrush. Goldenbush (*Isocoma meziesii*) and bush lupine (*Lupinus albifrons*, *L. arboreus*) also occur. **Coreopsis scrub** occurs in a few sites on the northern and eastern bluffs. The Coreopsis canopy is not as high as on the other islands, but the stands tend to be quite dense.

Santa Rosa Island

The vegetation of Santa Rosa Island is more diverse than that of the other islands due to Santa Rosa Island's greater size and elevational range. **Grassland** dominated by exotic annual grasses is again the most prevalent community. Native perennial grasses retain dominance in some areas such as Carrington Point where saltgrass (*Distichlis spicata*) covers many acres. **Caliche scrub** occurs on the west end of the island just as on San Miguel Island. Whereas San Miguel Island locoweed (*Astragalus miguelensis*) was the dominant shrub in caliche on San Miguel Island, goldenbush is more frequent on Santa Rosa Island. **Coastal bluff scrub** has vegetation similar to caliche scrub, notably goldenbush and San Miguel Island locoweed. It occurs primarily on the northern and western coastal bluffs and comprises habitat for soft-leaved paintbrush (*Castilleja mollis*), a federally Endangered species. **Lupine scrub** is an unusually dynamic plant community. The two species of bush lupine exhibit distinct boom and bust cycles, apparently in response to rapid growth, a short life span, and competition for moisture in dense stands (Davidson and Barbour 1977). A large portion of Carrington Point oscillates between dense lupine cover and grassland. On Santa Rosa Island, coyotebrush dominates enough of the landscape to warrant a distinct community, **baccharis scrub**. Sagebrush and goldenbush are minor components of this community, and there are no chaparral species. That baccharis scrub is transitional to another shrub community is one of the hypotheses that vegetation monitoring is intended to test. **Coastal sage scrub,** along with grassland and baccharis scrub, is one of the more common plant communities on the island. As on the other islands, it occurs on steep slopes. Unlike the other islands, it is not confined to southern exposures. **Coastal strand** occurs on unconsolidated dunes near beaches and coastal rocks. It is very similar to the coastal dune community on San Miguel. Another coastal community unique to the east end of Santa Rosa Island is **Coastal marsh**. Low-growing, salt-tolerant species such as salt grass (*Distichlis spicata*), pickleweed (*Salicornia viginica*), *Frankenia salina*, and *Jaumea carnosa* dominate these small seasonally inundated marshes. One area supports a vigorous coyote brush population. Federally Endangered Western Snowy Plovers (*Charadrius alexandrinus nivosus*) nest in marsh vegetation at the upper beach edges and Mallards (*Anas platyrhynchos*) nest along the brackish estuary.

Freshwater-dependent plant species occur in the riparian herbaceous and riparian woodland communities. **Riparian herbaceous** vegetation is by far the more common community. It occurs in association with all perennial streams and many of the ephemerals. Grasses and rushes are the most common plants, including upland as well as riparian-dependent species. Vegetated sections are frequently interspersed with sandbars or bare soil. Cattails (*Typha domingensis*) occur in some pools. Aside from a few scattered willows, **riparian woodland** occurs only in Lobo Canyon on the north side of the island. Arroyo willow (*Salix lasiolepis*), black cottonwood (*Populus balsamifera* s. *trichocarpa*), and elderberry (*Sambucus mexicana*) occur in discrete clumps mostly in the lower stream reaches.

Tree species are also found in chaparral, mixed woodland, Torrey pine woodland, Santa Cruz Island pine woodland, and oak woodland. **Chaparral** is strongly associated with the Monterey shale formation that underlies Black Mountain in the east-central part of the island. Small patches are also found near East Point and South Point. Scrub oak (*Quercus pacifica*), chamise (*Adenostoma fasciclatum*), toyon (*Heteromeles arbutifolia*), coyotebrush, and monkey flower (*Mimulus flemingii*) are frequently found together; tree poppy (*Dendromecon rigida*) and manzanita (*Arctostaphylos confertiflora, A. tomentosa*) are occasionally found. The scrub oak, chamise, and manzanita show upright and prostrate forms depending on the amount of wind exposure. **Mixed woodland** occurs primarily in the larger canyons in the northeast portion of the island. Tree species that occur there are coast live oak (*Quercus agrifolia*), island oak (*Q. tomentella*), island cherry (*Prunus ilicifolia* ssp. *lyonii*), and ironwood (*Lynothamnus floribundus* ssp. *asplenifolius*). Arborescent shrubs that occur in mixed woodland are toyon and scrub oak. Generally, one of these species strongly dominates a stand while the others are absent or insignificant. **Torrey pine woodland** is represented by only two stands on the island, both on the east end. There is variation within the stands; some areas are closed canopy monotypic *Pinus torreyana* sites while other areas are open and grassy with several tree and shrub species present in the understory. **Santa Cruz Island pine** is most developed on the north side of Black Mountain. There are scattered individuals on other parts of the island. *Pinus remorata* is similar to *P. torreyana* in its variability of density. However, while shrub and herbaceous cover increase in the less dense sites, other tree species do not occur. **Oak woodland** is defined by the presence of island oak that is endemic to the northern Channel Islands. This community occurs only on Soledad Peak and Black Mountain frequently in monotypic stands with no understory vegetation. Some oak groves also contain toyon.

Techniques

Plant communities are sampled according to protocols defined in the *Terrestrial Vegetation Monitoring Handbook* (Halvorson et al. 1988). Permanent 30-m point intercept transects were established in the major plant communities of each island (Halvorson et al. 1988; Clark et al. 1990). In the spring of each year, species presence is recorded at each of 100 points, spaced 30 cm apart on each transect. The height of the tallest plant at each point is recorded. Each transect and its surrounding vegetation are photographed. Transects on Santa Barbara Island and Anacapa Island that were installed by Santa Barbara Botanic Garden are 130 points long (40 m). Some of these run down one slope of a canyon and up the other. These have been split into 2 short transects (approximately 65 points each) so that the affects of different aspects are not mixed.

The monitoring season typically begins in mid-to-late February and continues through mid-to-late June. Dates for monitoring on each island are shown in Appendix A.

All transect data were entered on data sheets in the field or voice recorded on a tape recorder and transcribed onto data sheets at the field station. After proofreading and species verification, all data were entered into the Park's LandVeg database and proofread again. The data sheets are archived at Channel Islands National Park. Digital data management was described in detail in the 1988 *Terrestrial Vegetation Monitoring Handbook*, but that section is now outdated. Data were stored and analyzed in dBase from 1984 through 1995. All data were transferred to Microsoft® Access in 1995. A complete description of the new data management protocols will be included in the next edition of the *Terrestrial Vegetation Monitoring Handbook*.

All researchers used 50-m fiberglass tapes to delineate the transects. *Point poles* marked in 5-cm increments were held vertically at points every 30 cm along the transect to determine species and height. The instrument used for the point pole has been changed at least twice since monitoring began in 1984. The original instrument was a *range pole*; this was used in 1984 and 1985. From 1986 through 1990, botanists used a 1-inch diameter *PVC pipe* that was slightly smaller in diameter than the range pole. In 1993, the instrument was changed again to the *ski poles* that are currently in use. The ski poles are slightly smaller in diameter than the PVC pipe.

Transects have been read from "A to B", from "B to A", and, when two botanists work on the same transect, from both ends toward the middle. The "A" point is the zero point on the transect and the tape delineating it. The "B" point is the opposite end of the transect. These points are marked with aluminum, rebar, or Carsonite stakes. In some cases, data that were collected in a "B to A" direction were also entered on the data sheet in that order. Wherever these *backward* data were recognized, it has been noted on the data sheet and reentered in the correct order in the database.

Substrate material (for example, soil and litter) has been recorded differently over time. In 1984 and 1989, substrate was usually recorded only for those points where no vegetation was intercepted. In 1985 through 1988, 1993, and 1994, substrate was sometimes recorded at all points and sometimes only at those points without vegetation. By 1995, recording substrate at all points was standard on all islands. This more comprehensive substrate information is intended to reveal changes in soil disturbance and litter deposition.

Sources of Errors

There are two primary types of error in the vegetation data. The first occurs when the wrong species code is entered at a point due to either misidentification or misspelling. This may happen on the data sheet or during entry into the database. Several error searches are performed during data management in order to minimize the number of incorrect codes in the database. Vouchers of plants whose identification is uncertain are collected for examination by other botanists. During data entry, many code errors are caught by Microsoft® Access, as it will accept only codes already entered in the Species List database. Error-checking queries are run on the database after all data have been entered in order to detect missing or inappropriate codes or values.

Species identification is questionable in some cases. Grasses may have not yet matured sufficiently for good species identification or some herbaceous annuals may have already become desiccated. In both cases, identification was made to the finest possible level. Assumptions about a plant's identification were made only when previous years' data strongly pointed to a particular species. Uncertain species identifications were left on the data sheets, but a broader, verifiable level of identification was entered in the database, though this might be only family or even life form. Codes entered into the database that differ from the data sheets are noted in red ink on the sheets next to the original entry.

The second type of error occurs when the transect and points are not in exactly the same place as previous years. The aluminum stakes that mark the transects are difficult to see in tall grass or shrubs and cannot always be found. In these cases, a substitute transect may be put out using transect photographs and distances and compass bearings from known landmarks as described in the *Terrestrial Vegetation Monitoring Handbook*. These are as close as possible to the presumed original location, but they are not exact. Transects which have been relocated, temporarily or permanently, are described in the "Departures from Protocols" section of this report.

High winds are common during the sampling season. Even when tapes are pulled taut and close to the ground, some swaying occurs. This causes the sampled points to be offset to one side or the other from the actual transect which can result in a different species composition. Averaging the data from multiple transects in order to describe plant community composition provides some resilience to this type of error.

Sampling of too large an area can occur when researchers are not consistent about what proportion of the point pole they consider a hit. Some may record species that touch anywhere around the circumference which would lead to more hits being recorded at a point than another researcher who counts only what touches the half of the pole facing the tape. Which side of the tape the pole is placed on becomes a bigger source of species variability if hits on all sides of the pole are recorded. Again, averaging the transect data within each community decreases the impact of these inconsistencies.

Taxonomic Questions

Plant names used in the vegetation monitoring program are according to Hickman (1993) except where island taxa were not recognized as distinct from those on the mainland and were lumped with those species. In these cases, taxonomy is according to Munz (1974).

Plants that could not be identified during transect sampling were collected and keyed at the field station or brought to the mainland for identification by other Park staff and local experts. These collections are often maintained at the Park for future reference or sent to the Santa Barbara Botanic Garden for long-term curation. Specimens that have not been identified to species appear in the species lists without a specific epithet after the generic name or as "unknown herb", "unknown grass", and so forth.

Plant identification has been particularly difficult or inconsistent for some species. For example, on Santa Rosa Island, there has been uncertainty about identification of *Arctostaphylos confertiflora* and *A. tomentosa*. Both names have been used on the transects, though both may not be present. Identification of the several *Agrostis* and *Polypogon* species on Santa Rosa Island is also inconsistent. One is alerted to possible misidentifications when the transect data show a sudden switch from one species to another or vacillation between two species that never occur together in the same year. This is particularly true of perennial plants that should not completely disappear in a single year. The data presented in this report are "as collected" rather than making assumptions about what researchers saw.

In some cases, researchers have lumped together species or subspecies of annual grasses (for example, *Vulpia bromoides/myuros*). Because the species appear to play the same roles in their communities, we feel that lumping them causes less loss of information than would misidentification. Where researchers did identify to species level, these names have been preserved in the database. For this reason, one will occasionally see a single species name and a lumped species name in the data tables (Appendix G). For analysis, it is recommended to sum the hits of the single- and lumped-name taxa (*V. bromoides* plus *V. myuros* plus *V. bromoides/myuros*).

All known instances of species lumping and unclear identification are included in Appendix G.

Departures from Protocols

While there is variation every year in which transects get read due to weather, missing markers, nesting seabirds, and so on, most transects are read in most years. Notable exceptions to this have been 1989 (Anacapa Island, Santa Barbara Island, San Miguel Island), 1991 (Anacapa Island, Santa Barbara Island, San Miguel Island, and Santa Rosa Island), and 1992 (all islands) when no data collection was done.

Transect 9N on Santa Barbara Island and Transect 11 on San Miguel Island have been abandoned due to high cactus density; they are still photographed on an annual basis. SMI-11 has been replaced with SMI-18. Transects 4, 10N, and 10S on Santa Barbara Island and 02W and 03W on Anacapa Island have not been abandoned, but their sampling has become sporadic and unpredictable due to brown pelicans nesting on or near them. This is expected to continue. Transect 04W on Anacapa Island has not been sampled regularly because of its steepness and researchers' concern over damage to the vegetation.

Some transects become "lost" when their stakes get pulled up or broken off or when they are obscured by dense vegetation. In these cases, the missing "A" and/or "B" points of the transect are resurveyed using directions from the *Terrestrial Vegetation Monitoring Handbook*. Every effort is made to place the new transect as close as possible to the original, and a note is made on the data sheet so that it is clear that the data may be from a slightly different line.

Santa Barbara Island

Transects 1, 3, 4, 5, 7, 8N, 8S, 9N, 9S, 10N, 10S, 13, 15, 16, 17, 18, and 19 were read in the exact same location every year. Transect 2 was resurveyed in 1993 and again in 1994; 1995 data were collected on the exact location as 1994. Transect 6 was resurveyed in 1993; and 1994 and 1995 were at that new location. Transect 11 may have been resurveyed in 1994; 1995 data were collected in the 1994 location. Transect 12 was resurveyed in 1993; and 1994 and 1995 were at that new location. Transect 14 may have been resurveyed in 1994; 1995 was read in 1994 location. Transect 20 was newly installed in 1994 and was resurveyed in 1995. Transect 21 was added in 1995.

Anacapa Island

East Anacapa and Middle Anacapa have excellent sampling histories. All five transects on each island have been read in every sampling year except for Transect 05E in 1984. It seems likely that the data sheet has been lost for this year rather than that the transect was not read. Transects 01W and 06W on West Anacapa have also been read every year, but brown pelican nesting on the island has prevented reading of some transects in some years. The pelicans move around, so there is variation in which transects get read each year. Transect 02W was read in 1984, 1985, and 1987. Transect 03W was read in 1984, 1985, 1986 and 1993. Transect 04W has been read in all years except 1986 and 1995 due to the steepness of the slope; pelicans have not nested here. Transect 05W was not done in 1994 for unknown reasons.

San Miguel Island

Transects 07 and 13 through 16 have been done every sampling year. Transects 01 through 06, 08 through 10, and 12 have been done all years except 1995. Transect 11 was done 1984 through 1990; it was abandoned in 1993 due to dense cactus. There is no Transect 17. Transect 18 was installed in 1994.

Santa Rosa Island

The large number of transects on Santa Rosa Island makes a narrative of what was done and changed each year infeasible. Transects have been relocated frequently due to breakage by the cattle or because people have pulled out the stakes. Instead of a narrative, the transect history is presented in Table 2.

Table 2 Santa Rosa Island transects and their repositioning each year from 1990–1995

TN*	1990	1993	1994	1995
01	Installed	1990 A and B [a]	1990 A and B	B extrapolated [b]
02	Installed	Not read	1990 A and B	Not read
03	Installed	Not read	1990 A and B	B extrapolated
04	Installed	1990 A and B	1990 A and B	1990 A and B
05	Installed	1990 A and B	1990 A and B	1990 A and B
06	Installed	1990 A and B	1990 A and B	B extrapolated
07	Installed	Not read	B extrapolated	Not read
08	Installed	A extrapolated	1993 A, 1990 B	Extrapolated both ends
09	Installed	Not read	Questionable	1994 A, B extrapolated
10	Installed	A extrapolated	1993 A, B extrapolated	1993 A, B extrapolated
11	Installed	Not read	1990 A and B	1990 A and B
12	Installed	Surrogate [c]	Questionable [d]	1994 A, B extrapolated
13	Installed	1990 A and B	1990 A and B	1990 A and B
14	Installed	Surrogate	1993 A, B extrapolated	1993 A, B extrapolated
15	Installed	Surrogate	1993 A, 1993 B	A extrapolated, 1993 B
16	Installed	Not read	Surrogate	Not read
17	Installed	Not read	Surrogate	1994 stake (guessed A and extrapolated B)
18	Installed	Not read	1990 A, B extrapolated	Not read
19	Installed	Not read	Surrogate	Not read
20	Installed	1990 A and B	1990 A and B	1990 A and B
21	Installed	1990 A and B	1990 A and B	1990 A and B
22	Installed	Not read	Surrogate	Not read
23	Installed	Not read	1990 A and B	Not read
24	Installed	Not read	Surrogate	Not read
25	Installed	Not read	1990 A and B	1990 A, B extrapolated
26	Installed	Not read	1990 A and B	Not read
27	Installed	Surrogate	1990 A and B	Not read
28	Installed	1990 A, B extrapolated	1990 A, 1993 B	Not read
29	Installed	Not read	1990 A and B	Not read
30	Installed	1990 A and B	1990 A and B	Not read
31	Installed	Not read	Surrogate	Not read
32	Installed	1990 A and B	1990 A and B	Not read
33	Installed	1990 A and B	1990 A and B	1990 A and B
34	Installed	1990 A and B	1990 A and B	1990 A and B
35	Installed	1990 A and B	1990 A and B	1990 A and B
36	Installed	1990 A and B	1990 A and B	1990 A and B
37	Installed	1990 A and B	1990 A and B	1990 A and B
38	Installed	1990 A and B	1990 A and B	Not read
39	Installed	A extrapolated, 1990 B	A extrapolated, 1990 B	Not read
40	Installed	Not read	1990 A and B	Not read
41	Installed	Not read	A extrapolated, 1990 B	1994 A, 1990 B
42	Installed	1990 A and B	1990 A and B	1990 A and B
43	Installed	1990 A and B	1990 A and B	A extrapolated, 1990 B
44	Installed	1990 A and B	1990 A and B	1990 A and B
45	Installed	Not read	1990 A and B	Not read
46	Installed	Surrogate	1990 A and B	Not read
47	Installed	Not read	Surrogate	Not read
48	Installed	Not read	Surrogate	Not read
49	Installed	1990 A and B	1990 A and B	Not read
50	Installed	1990 A and B	1990 A, B extrapolated	Not read

TN*	1990	1993	1994	1995
51	Installed	1 pole present, 1 extrapolated	1993 A (1990?), B extrapolated	Not read
52	Installed	1990 A and B	1990 A and B	1990 pole, unknown, but extrapolated northward
53	Installed	Not read	1990 A and B	A extrapolated, 1990 B
54	Installed	Not read	1990 A and B	Not read
55	Installed	1990 A and B	1990 A and B	Not read
56	Installed	1990 A and B	1990 A and B	1990 A and B
57	Installed	1990 A and B	1990 A and B	1990 A and B
58	Installed	Not read	1990 A and B	Not read
59	Installed	Not read	1990 A and B	1990 A, B extrapolated
60	Installed	Not read	1990 A and B	1990 A and B
61	Installed	1990 A and B	1990 A and B	1990 A and B
62	Installed	1990 A and B	1990 A and B	Not read
63	Installed	1990 A and B	1990 A and B	Not read
64	Installed	Not read	Not read	Not read
65	Installed	1990 A and B	1990 A and B	Not read
66	Installed	1990 A and B	1990 A and B	Not read
67	Installed	1990 A and B	1990 A and B	Not read
68	Installed	1990 A and B (rebar)	1990 A and B	1990 A and B
69	Installed	Not read	1990 A and B	Not read
70	Installed	1990 A and B	1990 A and B	1990 A and B
71	Installed	1990 A and B	1990 A and B	1990 A and B
72	Installed	1990 A and B	1990 A and B	Not read
73	Installed	1990 A and B	1990 A and B	1990 A and B
74	Installed	1990 A and B	1990 A and B	1990 A and B
75	Installed	Not Read	1990 A and B	1990 A and B
76	Installed	1990 A and B	1990 A and B	1990 A and B
77	Installed	1990 A and B	1990 A and B	Not read
78	Installed	1990 A and B	1990 A and B	1990 A and B
79	Installed	1990 A and B	1990 A and B	1990 A and B
80	Installed	1990 A, B extrapolated	A extrapolated, 1993 B	A extrapolated, 1993 B
81	Installed	Not read	Surrogate	Not read
82	Installed	Not read	1990 A and B	1990 A and B
83	Installed	Not read	1990 A and B	Not read
84	Installed	Not read	Surrogate	A extrapolated, 1994 B
85	Installed	Not read	A extrapolated, 1990 B	Not read
86	No	No	Installed	1994 A and B

[a] A and B are the beginning and end points, respectively, of the transect.

[b] Extrapolated points are resurveyed using distances and bearings in the *Terrestrial Vegetation Monitoring Handbook*. They are used when transect markers cannot be found. They may or may not be re-monumented at the time of resurveying.

[c] Surrogate transects are installed when neither end marker can be found. They are resurveyed using directions in the *Terrestrial Vegetation Monitoring Handbook* and are re-monumented.

[d] Questionable locations are noted when comments on the data sheets are unclear about whether a transect was exactly located or extrapolated.

*TN=Transect Number

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Notes—Transect 86 was installed in 1984 just upstream of the cattle exclosure in Lobo Canon. It was added as a comparison site for Transect 82 which occurs in a similar site inside the exclosure.

In 1997, the bases of the original 1990 stakes for Transect 24 were found. This location and the 1994 location do not overlap. The 1990 transect has convex topography and is more dominated by forbs; the 1994 location is concave and dominated by grasses.

Species composition on Transect 16 on Carrington Point changed significantly between 1990 and 1994 when a surrogate transect had to be installed. *Distichilis spicata* occurred on 60 points in 1990 and on zero points in 1994. *Leymus triticoides* was not recorded in 1990 but was hit 33 times in 1994. Due to the perennial nature of both species, it seems unlikely that there was a complete loss of one species and such rapid development of another in that time period. It is likely that the surrogate transect was located in a different phase of the grassland community.

RESULTS AND DISCUSSION

Species abundance data for each transect are presented in Appendix G.

The data shows a great deal of variation in the abundance of many species as well as the total amount of vegetation from year to year. Species with annual life histories typically show greater short-term natural variation in abundance due to their dependence on seed production and subsequent germination and survival. Perennials may be more resilient to annual variations in rainfall and temperature, so show fewer extreme short-term increases or decreases due to these factors. Sudden decreases in perennial abundance may be the result of excess defoliation during insect predation, disease, or over-consumption by wildlife or livestock.

Despite the large range of natural variation in the amount of vegetation intercepted on transects, a few years stand out as exceptionally divergent. In 1990, 118 of the 137 transects read had the fewest vegetation hits of any year during the 1984 through1995 period. In many cases, the total number of hits was less than half the number in the next lowest year. The reverse scenario occurred in 1993 when many transects showed significantly more vegetation than in other years.

The explanation for these unusual vegetation years is apparent when rainfall records for 1984 through 1995 are examined (Table 4). In Santa Cruz Island's central valley and at Becher's Bay on Santa Rosa Island, the annual precipitation was less than half the annual average during both the 1988 through 1989 and the 1989 through 1990 growing seasons. Two years of extreme drought lead to sharp declines in the number of annuals and decreased the production of new twigs and leaves on perennials. In contrast, the lush vegetation of 1993 followed 2 seasons of above average rainfall in the winters of 1991 through 1992 and 1992 through 1993.

Another interesting deviation from normal shows up in the 1995 Santa Rosa Island riparian transects (Transects 80 through 86). Nearly 3 times the normal rainfall occurred during winter 1994 through 1995; the resulting flooding stripped much of the riparian vegetation.

Table 4 Precipitation on Santa Cruz and Santa Rosa Islands, 1983 through 1995 (October 1–September 30)

Years	Rainfall (Inches)
Santa Cruz Island (Central Valley) **1904–1992 average = 19.80 inches**	
1983–1984	16.26
1984–1985	16.01
1985–1986	31.71
1986–1987	13.99
1987–1988	15.63
1988–1989	8.92
1989–1990	6.35
1990–1991	15.58
1991–1992	20.45
1992–1993	25.17
1993–1994	15.37
1994–1995	45.13
Santa Rosa Island (Becher's Bay) **1941–1995 average = 14.52 inches**	
1983–1984	10.32
1984–1985	11.95
1985–1986	25.74
1986–1987	11.14
1987–1988	18.53
1988–1989	6.32
1989–1990	5.66
1990–1991	14.95
1991–1992	19.67
1992–1993	21.57
1993–1994	14.49
1994–1995	43.28

Note--Direct comparison of averages between islands is not possible because of the differing transect lengths on some islands.

Table 6 Average number of hits per year for transects read on Santa Barbara Island (SBI), Anacapa Island (AI), and San Miguel Island (SMI)

	1984	1985	1986	1987	1988	1990	1993	1994	1995
SBI	135	186	217	162	195	44	213	132	209
ANI	167	200	214	234	248	78	285	229	233
SMI	161	158	183	214	196	109	230	191	224
SRI	--	--	--	--	--	121	238	239	189

While other plant communities on the island responded positively to the abundant rainfall (reflected in higher numbers of hits on transects), the number of hits on riparian transects dropped. The average number of hits per transect per year in 1995 are among the highest on all islands except Santa Rosa Island, the only island with riparian transects (Table 6).

Recommendations for Changes to the Protocols

Goals

Changes to the data collection or data management protocols should accomplish specific goals:

1. To increase data accuracy and comparability.
2. To enhance the power of the data to reveal vegetation condition and trend.
3. To accurately store and evaluate data.
4. To maximize data consistency within and between years.
5. To increase efficiency of data collection and management.
6. To protect the resources being monitored from sampling-caused impacts.

Recommendations

The recommendations presented here are intended to move the Terrestrial Vegetation Monitoring program toward these goals:

1. Convert Santa Barbara Botanic Garden (Philbrick 1978–1982) line-intercept data to point-intercept data and enter into Microsoft® Access to expand the period of sampling.
2. Modify woody community monitoring protocols. Point-intercept is not suitable for monitoring changes in density and stand structure.
3. Establish riparian monitoring protocols.
4. Establish microbiotic soil crust and litter/duff monitoring protocols.
5. Add a Transect 17 on San Miguel Island to increase data collected from the stabilized dune community.
6. Use a Global Positioning System to document transect locations.
7. Verify and correct all possible taxonomic inconsistencies.

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APPENDIXES

APPENDIX A

Personnel information

Monitoring Dates and Primary Personnel

Santa Barbara Island

Monitoring Dates		Primary Personnel
From	To	
4/9/84	4/12/84	J Lenihan / W Lennox
2/22/85	2/25/85	W Halvorson
5/18/85	5/20/85	R Clark
2/27/86	3/3/86	K Danielsen
8/28/86	8/28/86	W Halvorson
2/23/87	2/25/87	K Danielsen
3/2/87	3/2/87	K Danielsen
3/11/87	3/13/87	K Danielsen
2/22/88	2/27/88	R Clark
5/31/90	6/1/90	W Halvorson
6/26/90	6/27/90	K Danielsen
3/2/93	3/5/93	S Chaney
4/7/93	4/10/93	S Chaney
3/10/94	3/14/94	S Chaney
3/7/95	3/13/95	K Chess

Anacapa Island

Monitoring Dates		Primary Personnel
From	To	
4/6/84	4/6/84	J Lenihan / W Lennox
5/24/84	5/26/84	R Clark
2/12/85	2/15/85	W Halvorson
3/12/85	3/14/85	R Clark
3/7/86	3/9/86	R Clark
4/2/86	4/4/86	R Clark
4/7/87	4/9/87	C D'Antonio
5/7/87	5/8/87	K Danielsen
3/16/88	3/16/88	C D'Antonio
3/22/88	3/24/88	W Halvorson
4/1/88	4/1/88	C D'Antonio
5/7/90	5/7/90	W Halvorson
6/12/90	6/14/90	K Danielsen
7/5/90	7/5/90	W Halvorson
3/19/93	3/23/93	S Chaney
3/30/93	3/30/93	S Chaney
5/25/93	5/25/93	S Chaney
3/29/94	4/4/94	S Chaney

San Miguel Island

Monitoring Dates		Primary Personnel
From	To	
5/30/84	6/6/84	L Lenihan / W Lennox
3/20/85	3/24/85	R Clark
4/9/86	4/12/86	R Clark
4/23/87	4/27/87	K Danielsen
4/10/88	4/18/88	W Halvorson
4/27/90	5/1/90	K Danielsen
4/2/93	4/4/93	S Chaney
4/8/94	4/13/94	H David
4/11/95	4/13/95	S Junak

Santa Rosa Island

Monitoring Dates		Primary Personnel
From	To	
3/20/90	3/22/90	S Junak
4/3/90	4/9/90	W Halvorson
4/18/90	4/18/90	W Halvorson
5/15/90	5/17/90	W Halvorson
3/19/93	3/24/93	C Sellgren
5/4/93	5/10/93	S Chaney
5/15/93	5/20/93	S Chaney
6/3/93	6/7/93	H David
6/20/93	6/21/93	H David
7/12/93	7/12/93	S Chaney
4/12/94	4/18/94	S Chaney
4/22/94	4/24/94	H David
4/27/94	5/2/94	K Chess
5/11/94	5/12/94	S Chaney
5/18/94	5/23/94	K Chess
5/9/95	5/15/95	J Gibson
5/30/95	6/7/95	J Gibson
6/13/95	6/14/95	J Gibson
7/5/95	7/6/95	J Gibson

Personnel Affiliations and Period of Involvement

Personnel and Affiliation	Period of Involvement
Steve Veirs, Research Biologist, NPS	1983–1984
Jim Lenihan, Biotechnician, NPS	1983–1984
Bill Lennox, Biotechnician, NPS	1983–1984
Bill Halvorson, Research Biologist, NPS	1985–1990
Ronnie Clark, Biotechnician, NPS	1984–1988
Karen Danielsen, Biotechnician, NPS	1986–1990
Carla D'Antonio, Biotechnician, NPS	1987–1988
Steve Junak, Botanist, Santa Barbara Botanic Garden	1990, 1995
Cece Sellgren, Range Conservationist, NPS	1993
Sarah Chaney, Botanist, NPS	1993–1994
Kathryn McEachern, Research Ecologist, USGS/BRD	1993–1995
Heidi David, Biotechnician, NPS	1993–1995
Katie Chess, Biotechnician, NPS and USGS/BRD	1994–1995
Jen Gibson, Biotechnician, NPS	1995

APPENDIX B

Species name and species identification uncertainties

Santa Barbara Island

In 1995, confusion about the identity of *Bromus hordeaceus* and *Hordeum murinum* juveniles may slant data too heavily toward the brome. Young *B. arizonicus* may also have been identified as *B. hordeaceus*. On Transect 4, there is uncertainty about the identification of *B. arizonicus* and *B. carinatus* (1993, 1995).

Avenas were also too young to identify confidently in 1995, and so were recorded as *A. barbata/fatua*. On all transects but 6, 9S, and 12, *A. fatua* was recorded in all other years. On those, *A. barbata* was recorded in only 1 or 2 years with *A. fatua* all other years. While *A. barbata* does occur on Santa Barbara Island, it seems likely that it was a misidentification on the transects.

Erodium moschatum was recorded on Transect 8 in 7 years. In 1993, *E. cicutarium* was reported. *E. moschatum* is recorded for 5 years on Transect 15, then is called *E. cicutarium* in 1993. There may also be confusion between these species on Transects 12 and 19.

Opuntia littoralis was recorded on Transects 09N and 10N all years except 1993 when *O. oricola* was recorded on each.

Vulpias on Transects 09S, 12, 13, 14, 16, 17, and 21 were recorded as *V. bromoides/myuros* in 1995 when transects were read prior to grass anthesis. These were generally identified as *V. myuros* in other years. In 1987, *V. bromoides* (but not *V. myuros*) was recorded on Transect 12 and both were recorded on Transect 13. In 1988, only *V. bromoides* was recorded on Transect 13.

Anacapa Island

Identification of *Avena barbata* and *A. fatua* has been inconsistent on Transects 02E, 03E, and 04M. *Vulpia bromoides* and *V. myuros* identification also varies between years on Transects 03E, 04M, 05M, 01W, 03W, and 05W.

Eriogonum grande was identified as var. *grande* on Transects 03E and 02M in all years except 1995, when Steve Junak identified it as *E. grande* var. *rubescens*.

Opuntia littoralis was recorded on Transect 02M in 1988; *O. oricola* was recorded here in 1993. *O. littoralis* was recorded during 5 years on Transect 04W; in 1993, *O. oricola* was recorded.

A *Lepidium* was recorded as *L. nitidum* in 1987, as *L. sp*. in 1988, and as *L. oblongum* in 1993 and 1995.

There may be confusion between *Trifolium willdenovii* and *T. depauperatum* on Transects 05M and 01W. Identification of *Gilia clivorum* and *G. nevinii* is also unclear on Transect 01W.

Eriophyllum confertiflorum and *E. staechadifolium* have been alternately recorded in different years on Transects 01W, 02W, and 03W.

On Transects 03W, there were 25 hits on an unidentified shrub in 1984. This shrub may be *Epilobium canum* ssp. *angustifolium*. It is not listed in 1984, but it does occur in all the other years the transect was read.

San Miguel Island

Hordeum murinum has been problematic on many transects. Some years it is identified only to the species level, other years it is identified as *H. murinum* ssp. *glaucum* or *H. murinum* ssp. *leporinum*. The subspecies never occur together in the same year. This makes it seem likely that there is only one present and the other is a misidentification. It is probably best to lump the subspecies in with the species for the purpose of analysis.

Plantago elongata is recorded on Transect 2 in 1987; *P. erecta* is recorded in 1993. *P. erecta* is not otherwise known to occur on San Miguel; it is likely that the 1993 record is a misidentification. This has not been corrected in the database because of the possibility that either or both the recorded *P. elongata* and *P. erecta* are actually *P. ovata*.

Lotus scoparius was recorded on Transect 05 in 1984. *L. scoparius* is a mainland species not known to occur on any of the Park islands. The plant was likely *L. dendroideus* var. *dendroideus* which occurred regularly on the transect in subsequent years. This has been corrected in the database.

On Transects 07, 10, 11, and 15 *Avena fatua* is recorded in 1984. In every subsequent year, *A. barbata* is reported.

Eriophyllum confertiflorum and *E. staechadifolium* are both reported on Transect 07 but never together until 1995.

Lupinus arboreus was recorded on Transect 08 in 1984 through 1990; *L. albifrons* was recorded in 1993. There may be confusion between *Erodium cicutarium* and *E. moschatum* on Transect 15.

Intercepts recorded as *Juncus mexicanus* may really be *Poa douglasii*. It is possible that *Distichlis spicata* has also been mistakenly recorded. *D. spicata* is recorded in 1984 on Transects 12, 13, 14, and 16. It continues to be recorded on Transect 12 in subsequent years. On the other transects, however, it disappears, and *J. mexicanus* appears during 1985. In 1986, it drops out and *P. douglasii* appears except on Transect 16 where *J. mexicanus* is reported in 1987 and *P. douglasii* appears in 1988. *P. douglasii* continues to be recorded through 1995. *D. spicata* and *J. mexicanus* never reappear.

Transect 18 was installed in 1994 as a replacement for the cactus-choked Transect 11. Transect 11 has a southeast aspect while Transect 18 faces south-southwest. Transect 11 currently supports cactus, wild cucumber, morning glories, and baccharis along with sagebrush. Transect 18 has twice as much sagebrush, less than half as much morning glory, and no cactus, cucumber, or baccharis. While both may be representative of Coastal Sage Scrub, their data are not comparable. The deletion of Transect 11 and inclusion of Transect 18 may cause an apparent shift of status in the Coastal Sage Scrub community that does not reflect a change in actual conditions. Rather, it is a change in community definition due to a change in the phase of the community that is being monitored.

Santa Rosa Island

Difficulty in identification of *Vulpia bromoides* and *V. myuros* is apparent on many Santa Rosa Island transects. In some cases, there is vacillation between years; in other cases, surveyors identified the plants only to the genus level. It may be useful to lump all occurrences into the *V. bromoides/myuros* complex. Transects affected by this are 1, 4, 6, 8, 10, 12, 19, 21, 25, 27, 28, 30, 34, 42, 43, 44, 46, 56, 57, 59, 65, 72, 73, and 76.

There may be confusion about the identity of *Erodium botrys*, *E. moschatum*, *and E. cicutarium* on Transects 8, 9, 10, and 15.

There may be confusion about *Abronia maritima* and *A. umbellata* on Transect 3, between *Lolium multiflorum* and *L. temulentum* on Transect 10, between *Avena barbata* and *A. fatua* on Transects 10 and 11, and *Astragalus traskiae* and *A. trichopodus* on Transect 56 (this may be a case of applying a valid code—ASTR for *A. traskiae*—to the wrong plant, *A. trichopodus*).

There may be confusion between *Nasella pulchra* and *N. lepida* on Transects 11 and 53 and between *N. pulchra* and *Achnatherum diegoense* on Transect 62.

There is inconsistency in identification of *Trifoliums* on several transects. *Trifolium microcephalum* and *T. willdenovii* have both been recorded on Transect 30, *T. depauperatum* and *T. willdenovii* on

Transect 42, and *T. depauperatum* and *T. gracilentum* on Transect 44. These are all annual species, so it is possible that there is variation in what appears from year to year.

On Transect 13, *Quercus dumosa* was recorded in 1990. In all subsequent years, *Q. agrifolia* was recorded.

Some instances of *Arctostaphylos confertiflora* on Transects 13, 20, 63, 67, and 72 may be *A. tomentosa*.

On Transect 65, it is likely that *Gnaphalium* sp. is *G. bicolor* and *Carex* sp. is *C. globosa* as these are the species identified there in other years.

No *Lactuca* sp. have been recorded on any Santa Rosa Island transects (Appendix F). This is surprising, as *L. serriola* and *L. saligna* are very common throughout the grasslands. It is possible that some hits recorded as *Sonchus oleracea* were actually *Lactuca*.

APPENDIX C

All plant species intercepted on Santa Barbara Island transects, 1984 through 1995

A
Achillea millefolium
Amblyopappus pusillus
Amsinckia menziesii var. intermedia
Aphanisma blitoides
Artemisia californica
Astragalus traskiae
Atriplex californica
Atriplex pacifica
Atriplex semibaccata
Avena barbata
Avena fatua

B
Bromus arizonicus
Bromus carinatus ssp. carinatus
Bromus hordeaceus
Bromus madritensis ssp. rubens
Bromus trinii

C
Cakile maritima
Calystegia macrostegia ssp. amplissima
Chenopodium californicum
Chenopodium murale
Claytonia perfoliata ssp. mexicana
Coreopsis gigantea
Crassula connata
Cryptantha clevelandii
Cryptantha maritima

D
Dichelostemma capitatum

E
Eriogonum giganteum var. compactum
Erodium cicutarium
Erodium moschatum
Eschscholzia californica

G
Galium aparine

H
Hemizonia clementina
Hordeum murinum ssp. glaucum

L
Lamarckia aurea
Lasthenia californica
Lepidium nitidum ssp. nitidum
Lycium californicum

M
Malacoth rix foliosa ssp. philbrickii
Malephora crocea
Malva parviflora
Marah macrocarpus
Medicago polymorpha
Melica imperfecta
Melilotus indicus
Mesembryanthemum crystallinum
Mesembryanthemum nodiflorum
Mirabilis californica
Moss
Muhlenbergia microsperma

O
Opuntia littoralis
Opuntia oricola
Opuntia prolifera

P
Parapholis incurva
Parietaria hespera
Perityle emoryi
Phacelia distans
Phalaris minor
Pholistoma auritum
Pholistoma racemosum
Platystemon californicus var. californicus
Pterostegia drymarioides

S
Scleranthus annuus
Silene gallica
Sonchus asper
Sonchus oleraceus
Suaeda taxifolia

T
Trifolium willdenovii

V
Vulpia bromoides
Vulpia myuros
Vulpia octoflora

APPENDIX D

All plant species intercepted on Anacapa Island transects, 1984 through 1995

A
Achillea millefolium
Agrostis viridis/stolonifera
Allium praecox
Amblyopappus pusillus
Amsinckia menziesii var. intermedia
Anagallis arvensis
Apiastrum angustifolium
Artemisia californica
Atriplex californica
Atriplex semibaccata
Avena barbata
Avena fatua

B
Baccharis pilularis
Bromus carinatus ssp. carinatus
Bromus carinatus ssp. maritimus
Bromus carinatus/arizonicus
Bromus diandrus
Bromus hordeaceus
Bromus madritensis ssp. rubens
Bromus maritimus
Bromus trinii

C
Calystegia macrostegia ssp. macrostegia
Castilleja affinis
Castilleja lanata ssp. hololeuca
Cerastium glomeratum
Chenopodium murale
Claytonia perfoliata ssp. perfoliata
Coreopsis gigantea
Crassula connata

D
Daucus pusillus
Delphinium parryi
Dichelostemma capitatum
Distichlis spicata
Dodecatheon clevelandii ssp. insulare
Dudleya caespitosa

E
Encelia californica
Epilobium canum ssp. angustifolium
Eriogonum arborescens
Eriogonum grande var. grande
Eriogonum grande var. rubescens
Eriophyllum confertiflorum
Eriophyllum staechadifolium
Erodium cicutarium
Erodium moschatum
Eucrypta chrysanthemifolia

F
Frankenia salina

G
Galium angustifolium var. foliosum
Galium aparine
Gilia clivorum
Gilia nevinii
Gnaphalium bicolor
Gnaphalium californicum
Gnaphalium canescens var. microcephalum
Grindelia camporum var. bracteosum
Guillenia lasiophylla

H
Hazardia detonsa
Hemizonia clementina
Hordeum brachyantherum
Hordeum intercedens
Hordeum murinum ssp. glaucum

I
Isocoma menziesii

L
Lamarckia aurea
Lasthenia californica
Lathyrus vestitus ssp. vestitus
Lepidium nitidum var. nitidum
Lepidium oblongum var. insulare
Lessingia filaginifolia var. filaginifolia
Leymus condensatus
Lotus dendroideus var. dendroideus
Lupinus albifrons
Lupinus bicolor

M
Malacothrix saxatilis var. implicata
Malephora crocea
Malva parviflora
Marah macrocarpus
Medicago polymorpha
Melica imperfecta
Melilotus indicus
Mesembryanthemum crystallinum
Mesembryanthemum nodiflorum

Microseris heterocarpa
Mimulus flemingii
Mirabilis californica
Moss
Muhlenbergia microsperma

N
Nasella pulchra

O
Opuntia littoralis
Opuntia oricola
Opuntia prolifera

P
Parapholis incurva
Parietaria hespera
Pellaea andromedifolia
Pentagramma triangularis ssp. triangularis
Phacelia distans
Phalaris minor
Poa secunda
Polypodium californicum
Pterostegia drymarioides

R
Ranunculus californicus var. californicus

S
Sanicula arguta
Selaginella bigelovii
Senecio vulgaris
Silene gallica
Silene laciniata ssp. major
Sonchus oleraceus
Spergularia macrotheca var. macrotheca
Stellaria media
Suaeda taxifolia

T
Trifolium depauperatum
Trifolium willdenovii

V
Vulpia bromoides
Vulpia myuros
Vulpia octoflora

Z
Zigadenus fremontii

APPENDIX E

All plant species intercepted on San Miguel Island transects, 1984 through 1995

A
Abronia maritima
Abronia umbellata
Achillea millefolium
Allium praecox
Amblyopappus pusillus
Ambrosia chamissonis
Amsinckia menziesii var. intermedia
Artemisia californica
Astragalus curtipes
Astragalus miguelensis
Atriplex californica
Atriplex semibaccata
Avena barbata
Avena fatua

B
Baccharis pilularis
Bromus arizonicus
Bromus carinatus ssp. carinatus
Bromus carinatus ssp. maritimus
Bromus diandrus
Bromus hordeaceus
Bromus madritensis ssp. rubens
Bromus maritimus

C
Cakile maritima
Calandrinia ciliata var. menziesii
Calystegia macrostegia ssp. macrostegia
Camissonia cheiranthifolia var. cheiranthifolia
Camissonia micrantha
Carpobrotus chilensis
Castilleja exserta
Castilleja lanata ssp. hololeuca
Cerastium glomeratum
Chenopodium californicum
Cirsium occidentale
Claytonia perfoliata ssp. perfoliata
Conyza canadensis
Coreopsis gigantea
Crassula connata
Cryptantha clevelandii

D
Daucus pusillus
Dichelostemma capitatum
Distichlis spicata var. stolonifera
Dudleya caespitosa
Dudleya greenei

E
Erigeron glaucus
Eriogonum grande var. rubescens
Eriophyllum confertiflorum
Eriophyllum staechadifolium
Erodium cicutarium
Erodium moschatum
Erysimum insulare
Eschscholzia californica

F
Frankenia salina

G
Galium aparine
Gnaphalium luteo-album

H
Hordeum brachyantherum
Hordeum murinum ssp. glaucum
Hordeum murinum ssp. leporinum

I
Isocoma menziesii

J
Juncus mexicanus

L
Lamarckia aurea
Lasthenia californica
Layia platyglossa
Lessingia filaginifolia var. filaginifolia
Leymus triticoides
Lotus dendroideus var. dendroideus
Lotus scoparius
Lupinus albifrons
Lupinus arboreus
Lupinus succulentus

M
Malacothrix incana
Malacothrix saxatilis var. implicata
Malva parviflora
Marah macrocarpus
Marrubium vulgare
Medicago polymorpha
Melilotus indicus
Mesembryanthemum crystallinum
Mesembryanthemum nodiflorum

N
Nasella pulchra
Nemophila pedunculata

O
Opuntia littoralis

P
Parapholis incurva
Phacelia distans
Phalaris minor
Plantago elongata
Plantago erecta
Platystemon californicus var. californicus
Poa douglasii
Polypogon monspeliensis
Pterostegia drymarioides

S
Senecio vulgaris
Silene gallica
Sisyrinchium bellum
Solanum douglasii
Sonchus oleraceus
Spergularia macrotheca var. macrotheca
Stellaria media

T
Torilis nodosa

V
Vulpia bromoides
Vulpia myuros

APPENDIX F

All plant species intercepted on Santa Rosa Island transects, 1984 through 1995

A
Abronia maritima
Abronia umbellata
Achillea millefolium
Achnatherum diegoense
Achyrachaena mollis
Adenostoma fasciculatum var. fasciculatum
Adiantum jordanii
Agrostis pallens
Agrostis viridis
Amblyopappus pusillus
Ambrosia chamissonis
Amsinckia menziesii var. intermedia
Anagallis arvensis
Arctostaphylos confertiflora
Artemisia californica
Astragalus miguelensis
Astragalus traskiae
Astragalus trichopodus var. lonchus
Atriplex californica
Atriplex semibaccata
Avena barbata
Avena fatua

B
Baccharis pilularis
Bloomeria crocea
Bowlesia incana
Brodiaea jolonensis
Bromus arizonicus
Bromus carinatus
Bromus diandrus
Bromus hordeaceus
Bromus madritensis ssp. rubens

C
Cakile maritima
Calandrinia breweri
Calandrinia ciliata var. menziesii
Calochortus albus
Calystegia macrostegia ssp. macrostegia
Camissonia cheiranthifolia ssp. cheiranthifolia
Camissonia micrantha
Capsella bursa-pastoris
Cardamine californica
Cardionema ramosissimum
Carex globosa
Carex pansa
Carpobrotus chilensis
Castilleja exserta
Centaurea melitensis
Cerastium glomeratum
Chenopodium californicum
Chenopodium murale
Cirsium occidentale
Cirsium vulgare
Clarkia davyi
Clarkia epilobioides
Claytonia perfoliata ssp. perfoliata
Cotula australis
Cotula coronopifolia
Crassula connata
Cressa truxillensis var. vallicola
Cryptantha clevelandii
Cryptantha micromeres
Cynodon dactylon

D
Daucus pusillus
Dichelostemma capitatum
Dichondra occidentalis
Distichlis spicata var. stolonifera

E
Eleocharis acicularis
Eleocharis macrostachya
Elymus sp.
Epilobium canum ssp. angustifolium
Erigeron glaucus
Erigeron sanctarum
Eriogonum grande var. rubescens
Eriophyllum confertiflorum
Erodium botrys
Erodium cicutarium
Erodium moschatum
Eschscholzia californica

F
Filago californica
Frankenia salina

G
Galium angustifolium ssp. foliosum
Galium aparine
Galium nuttallii ssp. insulare
Gastridium ventricosum
Geranium dissectum
Gilia achilleifolia ssp. multicaulis
Gilia clivorum
Gnaphalium bicolor
Gnaphalium californicum
Gnaphalium luteo album
Gnaphalium purpureum

Gnaphalium stramineum
Grindelia camporum var. bracteosum
Guillenia lasiophylla

H

Helianthemum scoparium
Hemizonia fasciculata
Heteromeles arbutifolia
Hieracium argutum
Hordeum brachyantherum
Hordeum intercedens
Hordeum murinum
Hypochaeris glabra

I

Isocoma menziesii
Isomeris arborea

J

Jaumea carnosa
Juncus bufonius
Juncus mexicanus
Juncus phaeocephalus var. phaeocephalus

K

Keckiella cordifolia
Koeleria macrantha

L

Lamarckia aurea
Lasthenia californica
Layia platyglossa
Lepidium lasiocarpum var. lasiocarpum
Lepidium nitidum var. nitidum
Lepidium virginicum var. pubescens
Lessingia filaginifolia var. filaginifolia
Leymus condensatus
Leymus pacificus
Leymus triticoides
Lolium multiflorum
Lolium perenne
Lolium temulentum
Lomatium caruifolium
Lotus dendroideus var. dendroideus
Lotus strigosus
Lotus wrangelianus
Lupinus albifrons
Lupinus arboreus
Lupinus bicolor
Lupinus concinnus var. agardhianus
Lupinus succulentus
Luzula comosa
Lyonothamnus floribundus ssp. aspleniifolius

M

Malacothrix incana
Malephora crocea
Malva parviflora
Marah macrocarpus
Medicago polymorpha
Melica imperfecta
Melilotus indicus
Mesembryanthemum crystallinum
Mesembryanthemum nodiflorum
Micropus californicus
Microseris douglasii ssp. tenella
Microseris heterocarpa
Microseris linearifolia
Mimulus flemingii
Mimulus guttatus
Moss
Muhlenbergia microsperma

N

Nasella lepida
Nasella pulchra
Navarretia atractyloides

O

Opuntia littoralis

P

Parapholis incurva
Parietaria hespera
Pellaea andromedifolia
Pentagramma triangularis ssp. triangularis
Phacelia distans
Phacelia ramosissima var. austrolitoralis
Pinus muricata forma remorata
Pinus torreyana ssp. insularis
Plagiobothrys collinus
Plantago erecta
Plantago ovata
Platystemon californicus var. californicus
Poa douglasii
Poa secunda
Polygonum arenastrum
Polypodium californicum
Polypogon interruptus
Prunus ilicifolia ssp. lyonii
Pterostegia drymarioides

Q

Quercus agrifolia var. agrifolia
Quercus dumosa
Quercus macdonaldii
Quercus tomentella

R

Ranunculus californicus var. californicus
Rhus integrifolia
Rumex crispus

S
Salicornia virginica
Salix lasiolepis
Salvia brandegei
Sambucus mexicana
Sanicula arguta
Scirpus pungens
Selaginella bigelovii
Senecio vulgaris
Sidalcea malviflora
Silene gallica
Silene laciniata ssp. major
Silybum marianum
Sisyrinchium bellum
Solanum douglasii
Solidago californica
Sonchus asper
Sonchus oleraceus
Spergularia macrotheca var. macrotheca
Stachys bullata
Stellaria media
Stylocline gnaphalioides

T
Torilis nodosa
Trifolium depauperatum
Trifolium gracilentum var. palmeri
Trifolium microcephalum
Trifolium willdenovii
Triodanis biflora
Typha domingensis

U
Urtica urens

V
Vaccinium ovatum
Vicia americana
Vicia hassei
Viola pedunculata
Vulpia bromoides
Vulpia myuros
Vulpia octoflora

Z
Zigadenus fremontii

APPENDIX G

The number of interceptions of each species on each transect for each year the transect was read

This appendix presents the number of hits on each species on each transect for each year the transect was read. The locations of the species on the transect and the height of the highest intercept at each point are not displayed. The transects are grouped by island and are presented in numerical order.

Each transect is presented in its own table. The table has a title bar, a Lifeform column, a Species column, and annual data columns.

The title bar shows the island on which the transect occurs, the plant community the transect represents, and the number of points on the transect.

The Lifeform column indicates the life forms into which the plant species are grouped. Species are classified as trees, shrubs, sub-shrubs, graminoids, or other herbaceous forms, as annuals or perennials, and as natives or exotics. Sedges and rushes are part of the graminoid group. Sub-shrubs are distinguished by aboveground tissues that are predominantly non-woody, whereas shrubs have well-developed woody branches. The distinction between trees and arborescent shrubs is subjective. The following species are identified as trees:

Lyonothamnus floribundus
Pinus remorata
Pinus torreyana
Prunus lyonii
Quercus agrifolia
Quercus dumosa
Quercus macdonaldii
Quercus pacifica
Quercus tomentella
Salix lasiolepis
Sambucus mexicana

Below the Layer, Species, and Data columns are sections that show the total number of vegetation hits each year (necessary to compute relative frequency for each species), the number of hits on different substrates, and the percentage of the transect points where no vegetation was hit. Years in which a transect was not read are apparent by the empty column below that year's heading. As discussed in the Techniques section, substrate data were recorded differently from year to year. The type of recording in any given year can be determined by comparing the number of substrate hits with the number of transect points. Substrate hits will equal the number of points on the transect in years when substrate was recorded at every point.

The relative frequency of each species on a given transect can be calculated by dividing the number of hits on that species by the total number of plant interceptions on the transect. For example, on Transect 01E on Anacapa Island in 1984, there were 39 hits on *Malephora crocea*. There were 131 total vegetation hits. The relative frequency of *M. crocea* is (39 / 131) = 0.298. In other words, 29.8% of the hits on the transect were *M. crocea*. The sum of the relative frequencies on a transect should equal 1.0.

Canopy cover for each species can be extrapolated by dividing the number of hits on the species by the number of points on the transect. Transect 01E on Anacapa Island has 100 points. The canopy cover of *M. crocea* is (39 / 100) = 39%. The sum of the canopy covers can exceed 100%.